IS 15505 (2004, Reaffirmed 2010): Gaseous Fire Extinguishing Systems--HCFC Blend A Extinguishing Systems. ICS 13.220.10

IS 15505 : 2004

REAFFIRMED

भारतीय मानक

# गैसीय अग्नि शमन पद्धतियाँ — एचसीएफसी मिश्रण ए शमन पद्धतियाँ

*Indian Standard*

# GASEOUS FIRE EXTINGUISHING SYSTEMS — HCFC BLEND A EXTINGUISHING SYSTEMS

ICS 13.220.10



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Fire Fighting Sectional Committee, CED 22

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Fire Fighting Sectional Committee had been approved by the Civil Engineering Division Council.

It is important that the fire protection of building or plant be considered as a whole. HCFC blend A total flooding systems form only a part, though an important part, of the available facilities. However, it should not be assumed that their adoption necessarily removes the need to consider supplementary measures, such as the provision of portable fire extinguisher or mobile appliances for first air or emergency use, or measures to deal with special hazards.

HCFC blend A is recognized as effective for extinguishing Class A and Class B fires where electrical risks are present. Nevertheless, it should not be forgotten in the planning of the comprehensive schemes that there may be hazards for which this technique is not suitable, or that, in certain circumstances or situation, there may be danger in its use, requiring special precautions. Advice on these matters can be obtained from organizations involved with the installation of HCFC blend A total flooding systems.

System in complete shall be approved by any recognized/independent authority. Agent dump/discharge test be replaced by enclosure integrity test unless required by legal requirement.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values ( *revised* )'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# GASEOUS FIRE EXTINGUISHING SYSTEMS — HCFC BLEND A EXTINGUISHING SYSTEMS

## 1 SCOPE

**1.1** This standard sets out specific requirements for the design and installation of total flooding fire-extinguishing systems employing HCFC blend A gas extinguishant. This standard is applicable to single supply as well as distributed supply systems.

**1.2** This standard complements various general requirements applicable to all types of gaseous fire-extinguishing systems ( Halocarbon as well as Inert gas systems ) listed in IS 15493. As such, both these standards should be read together before designing a system. Where requirements in both the standards differ, this standard shall take precedence.

**1.3** This standard covers total flooding systems of HCFC blend A operating at nominal pressures of 2.5 MPa and 4.2 MPa only at 21°C.

## 2 REFERENCE

The standard given below contains provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

| *IS No.* | *Title* |
| --- | --- |
| 15493 : 2004 | Gaseous fire extinguishing systems — General requirements |

## 3 GENERAL INFORMATION

### 3.1 Application

**3.1.1** HCFC blend A total flooding system is designed to develop a controlled atmosphere in an enclosed space and extinguishes the fires by cooling the flame and breaking the free radical chain reaction and thereby interfering with the combustion process. The appropriate HCFC blend A concentration shall also be maintained until the temperature within the enclosure has fallen below the re-ignition point.

**3.1.2** The minimum HCFC blend A concentration necessary to extinguish a flame has been determined by experiments for several surface-type fires particularly those involving liquids and gases. For deep-seated fires, longer soaking times may be necessary but are difficult to predict.

**3.1.3** It is important that concentrations are not only achieved but also maintained for a sufficient period of time to allow effective emergency action by trained personnel. This is equally important in all classes of fires since a persistent ignition source can lead to a recurrence of the initial event once the HCFC blend A has dissipated.

## 4 GAS CHARACTERISTICS AND PROPERTIES

**4.1** HCFC blend A is a colourless, electrically non-conductive gas with a citrus like odour and with a density approximately three times that of air.

**4.2** HCFC blend A total flooding system can be used to extinguish all classes of fires. Information on use and limitations of HCFC blend A is available in IS 15493.

**4.3** HCFC blend A gas is a blend of various gases, the composition of which is as shown in Table 1.

**4.4** HCFC blend A is a blend of gases liquefied at suitable pressure and temperature, that can be stored in a pressurized container.

**4.5** HCFC blend A gas shall comply with specification as shown in Table 2. The purity of HCFC blend A shall be determined in accordance with Annex A.

**4.6** Physical properties of HCFC blend A gas is shown in Table 3.

**4.7** Toxicological information for HCFC blend A gas are shown in Table 4.

### 4.8 Container Characteristics

The maximum fill density, container working pressure of the HCFC blend A cylinders shall not exceed the values provided in Table 5 for systems operating at 2.5 MPa and 4.2 MPa respectively.

NOTES

1 For further data on pressure/temperature relationship, Fig. 1 and Fig. 2 shall be referred.

2 Exceeding the maximum fill density may result in the container becoming liquid full. With the result that an extremely high rise in pressure occurs with small increases in temperature that could adversely affect the integrity of the container assembly.

**Table 1 Composition of HCFC Blend A Gas**

( *Clauses* 4.3 *and* A-1 )

| Sl No. | Clean Agent Formulae | Chemical Name | Commercial Name | Tolerance ( Percent by Mass ) |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| i) | $CHCl_2CF_3$ | Dichloro trifluoro ethane ( HCFC – 123, 4.75 percent ) | HCFC blend A | ± 0.5 |
| ii) | $CHClF_2$ | Chloro difluoro methane ( HCFC – 22, 82 percent ) | | ± 0.8 |
| iii) | $CHClFCF_3$ | Chloro tetrafluoro ethane ( HCFC - 124, 9.5 percent ) | | ± 0.9 |
| iv) | $C_{10}H_{16}$ ( Detoxifier) | Iso proponyl-1-methyl cycol-hexane ( 3.75 percent ) | | ± 0.5 |

**Table 2 Specification for HCFC Blend A Gas**

( *Clause* 4.5 )

| Sl No. | Property | Requirement |
|---|---|---|
| (1) | (2) | (3) |
| i) | Purity | 99.6 percent by mass, *Min* |
| ii) | Moisture | $10 \times 10^{-6}$ by mass, *Max* |
| iii) | Acidity | $3 \times 10^{-6}$ by mass, *Max* |
| iv) | Non-volatile residue | 0.01 percent by mass, *Max* |
| v) | Suspended matter or sediment | None visible |

**Table 3 Physical Properties**

( *Clause* 4.6 )

| Sl No. | Property | Value |
|---|---|---|
| (1) | (2) | (3) |
| i) | Molecular mass | 92.9 |
| ii) | Boiling point at 0.1 MPa | - 38.3°C |
| iii) | Freezing point | < -107.2°C |
| iv) | Vapour pressure at 20°C | 825 kPa |
| v) | Specific volume of super-heated vapour at 1 bar and 20°C ( $m^3/kg$ ) | 0.259 |
| vi) | Critical temperature | 125°C |
| vii) | Critical pressure | 6.65 MPa |
| viii) | Critical volume | 170 $cm^3/mol$ |
| ix) | Critical density | 580 $kg/m^3$ |
| x) | Liquid density at 20°C | 1 200 $kg/m^3$ |
| xi) | Saturated vapour density at 20°C | 31 $kg/m^3$ |

### 4.9 Pressure *versus* Temperatures

To allow faster flow through piping systems, the natural pressure of HCFC blend A is often supplemented with dry nitrogen. Commonly used pressures are respectively 2.5 MPa and 4.2 MPa measured at 21°C. The respective vapour pressures of HCFC blend A as well as dry nitrogen vary with temperature.

**Table 4 Toxicological Information**

[ *Clauses* 4.7, 5.3 *and* 7.1(d) ]

| Sl No. | Property | Value |
|---|---|---|
| (1) | (2) | (3) |
| i) | No observed adverse effect level ( NOAEL ) | 10 percent |
| ii) | Lowest observed adverse effect level ( LOAEL ) | > 10 percent |
| iii) | 4 hour lethal concentration $LC_{50}$ | 64 percent |

**Table 5 2.5 and 4.2 MPa Storage Container Characteristics for HCFC Blend A**

( *Clause* 4.8 )

| Sl No. | Property | Value | |
|---|---|---|---|
| | | 2.5 MPa | 4.2 MPa |
| (1) | (2) | (3) | (4) |
| i) | Maximum fill density 900 $kg/m^3$ | 0.9 kg ( litre ) | 0.9 kg (litre) |
| ii) | Maximum container working pressure at 55°C | 3.5 MPa | 5.3 MPa |
| iii) | Superpressurization at 20°C | 2.5 MPa | 4.2 MPa |

### 4.10 Nitrogen Superpressurization

Nitrogen is soluble in HCFC blend A. Thus when a storage cylinder is pressurized with nitrogen, some dissolves in the liquid HCFC blend A and the rest remains in the vapour phase and combines with the vapour pressure of HCFC blend A to produce the pressure necessary to propel the HCFC blend A through the pipeline ( *see* Fig. 1 ).

## 5 SAFETY OF PERSONNEL

**5.1** Any hazard to personnel created by the discharge of HCFC blend A shall be considered in the design

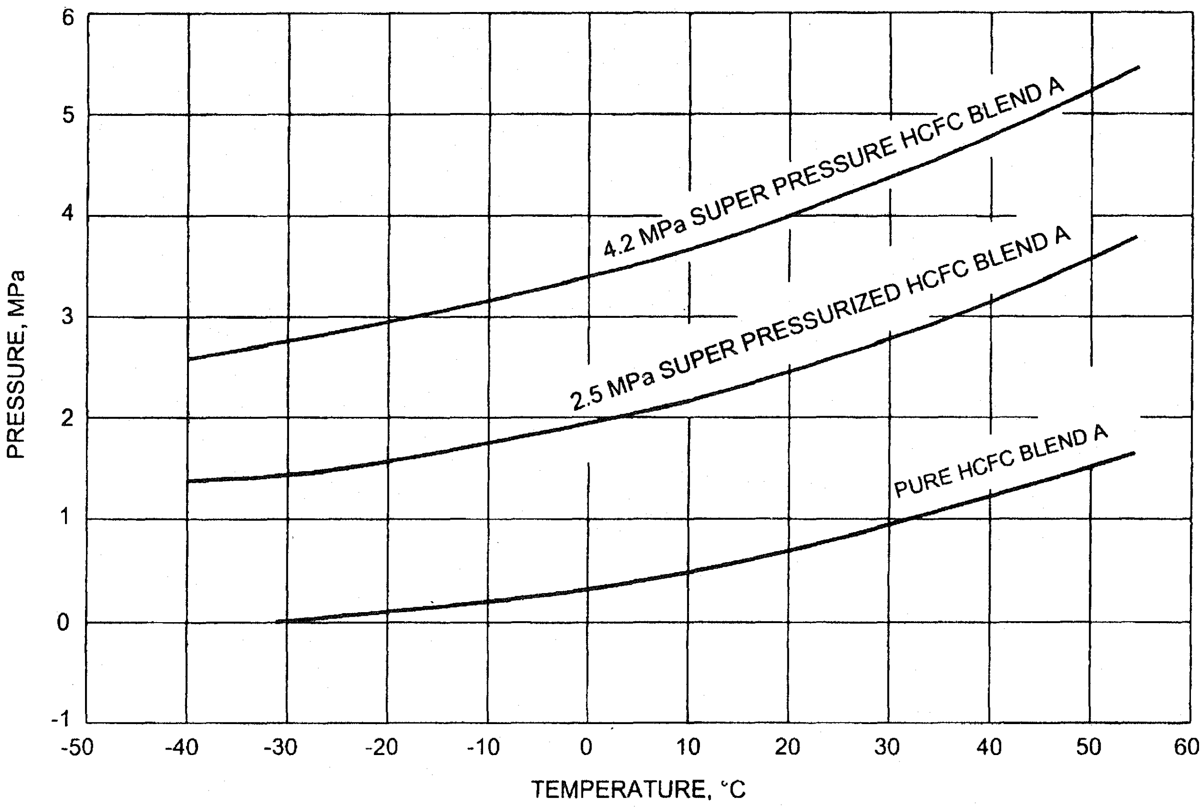



FIG. 1 PRESSURE/TEMPERATURE CURVES OF HCFC BLEND A

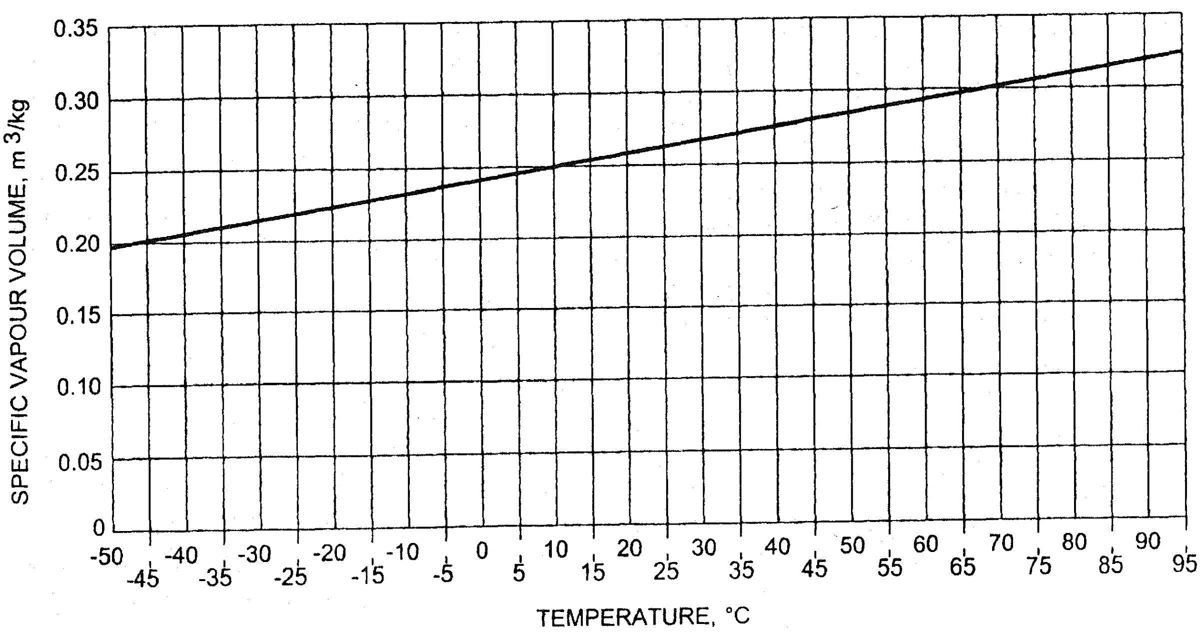



FIG. 2 SPECIFIC VOLUME OF SUPERHEATED HCFC BLEND A VAPOUR AT SEA LEVEL

of the system. Potential hazard can arise from the following:

a) Extinguishant itself,
b) Combustion products of the fire, and
c) Breakdown products of the extinguishant resulting from exposure to fire.

**5.1.1** In areas, where there is a likelihood of significant differences between gross and net volumes of the enclosure, utmost care shall be exercised in proper system design to ensure that maximum concentrations as given in **5.1**(c) are not exceeded.

**5.2** Where the design concentration exceeds the LOAEL, HCFC blend A shall be used only for total flooding in normally unoccupied areas. For minimum safety requirements, provisions laid down in **5** of IS 15493 shall be followed.

**5.3** Toxicological information of HCFC blend A is given in Table 4.

**5.4 Miscellaneous Hazards**

Some of the additional hazards are as below:

a) *Cold temperatures* — Direct contact with the vapourizing liquid being discharged from a HCFC blend A system will have a strong chilling effect on objects and can cause frostbite burns to the skin. The liquid phase vapourizes rapidly when mixed with air and thus limits the hazard to immediate vicinity of the discharge point.
b) *Visibility* — Discharge of HCFC blend A may create a light mist resulting from condensation of moisture in the air. However, the mist rarely persists after the discharge is completed. Thus little hazard is created from the standpoint of reduced visibility. Once HCFC blend A is discharged into an enclosure, its presence is easy to detect through the normal senses in concentrations above about 3 percent.
c) *Uneven distribution* — In total flooding systems, the high density of HCFC blend A vapour requires the use of discharge nozzles that will achieve a well-mixed atmosphere in order to prevent local pockets of higher concentration. HCFC blend A and HCFC blend A air mixtures are also more dense than air and will drift and accumulate in low spaces, such as cellars, pits and floor voids, and may be difficult to ventilate effectively.

## 6 VENTING ARRANGEMENT

Venting shall be provided at levels as high as possible in the enclosure. Allowable pressures for average enclosures shall be in conformity with the following guidelines. The building requirements for the type of enclosure and free venting required can also be calculated from the relevant specifications.

## 7 EXTINGUISHING AGENT SUPPLY

**7.1 Quantity**

a) *Quantity requirements ( main )* — The amount of the HCFC blend A in the system shall be at least sufficient for the largest single hazard protected or group of communicating hazards that are to be protected simultaneously.
b) *Quantity requirements ( reserve )* — Where required, the reserve quantity should be same as that of main supply as in **7.1**(a). However if replenishing of HCFC blend A gas supply takes more than 7 days at the site of installation, advice may be sought from the authority concerned on the quantity to be kept available as reserve.
c) *Uninterrupted protection* — Where uninterrupted protection is required, reserve supply and main supply should be permanently connected to the distribution piping and arranged for easy changeover to enable uninterrupted protection.
d) The quantity of the HCFC blend A required shall be further adjusted to compensate for any special conditions, such as unclosable openings, forced ventilation, the free volume of air receivers that may discharge into the risk, altitude ( substantially above or below sea level ) or any other causes for the extinguishant loss. However in no case the injected concentration of the HCFC blend A gas shall exceed its LOAEL ( *see* Table 4 ).

**7.2 Total Flooding Quantity**

All HCFC blend A total flooding systems shall be capable of producing the required concentration under the conditions of maximum net volume, maximum leakage and minimum expected ambient temperatures. Fig. 2 shows the specific volume of superheated HCFC blend A vapour at various temperatures.

a) The amount of HCFC blend A required to achieve the design concentration shall be calculated from the following equations and this figure shall need further adjustment as stated in **7.1**(d):

$$M = \frac{VC}{S(100 - C)}$$

where

$M$ = total flooding quantity, kg;

$C$ = design concentration, percent by volume;

$V$ = net volume of the hazard, $m^3$;

$S$ = $K_1 + K_2 (T)$, where $K_1$ and $K_2$ are constants specific to the agent used and $T$ is minimum temperature inside enclosure; and

$V_S$ = specific volume of superheated agent at 21°C, $m^3/kg$.

Specific volume constants for the HCFC blend A gas are $K_1 = 0.241\,3$ and $K_2 = 0.000\,88$. It may also be noted that this equation provides an allowance for the normal leakage from a tight enclosure to accomplish equalization of pressure.

b) The agent requirement per unit volume of protected space can also be calculated by using Table 6 for various levels of concentration corresponding to the temperature within the protected enclosure ( flooding factor obtained from Table 6 that is temperature of the enclosure *versus* gas concentration, multiplied by net volume of the enclosure ).

NOTE — Quantity of the agent shall be the highest of the values calculated from the provisions contained in **7.2**(a) and **7.2**(b).

**7.3** The actual quantity of HCFC blend A gas storage required shall be determined in the following manner, which shall further be subject to changes for pressure due to elevation [ *see* **8**(g) and Table 8 ].

**Table 6 Total Flooding Quantity ( HCFC Blend A )**

[ *Clause* 7.2(b) ]

| Sl No. | Temperature $T$ | Specific Vapour Volume, $S$ | HCFC Blend A Mass Requirements per Unit Volume of Protected Space ( $kg/m^3$ ) Design Concentration by Volume, $C$, Percent | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | °C | $m^3/kg$ | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
| i) | -35 | 0.210 | 0.358 | 0.413 | 0.470 | 0.528 | 0.588 | 0.648 | 0.710 | 0.774 | 0.839 | 0.906 |
| ii) | -30 | 0.215 | 0.351 | 0.405 | 0.461 | 0.517 | 0.576 | 0.635 | 0.696 | 0.758 | 0.822 | 0.887 |
| iii) | -25 | 0.219 | 0.343 | 0.397 | 0.451 | 0.507 | 0.564 | 0.622 | 0.682 | 0.743 | 0.805 | 0.869 |
| iv) | -20 | 0.224 | 0.337 | 0.389 | 0.442 | 0.497 | 0.553 | 0.610 | 0.668 | 0.728 | 0.790 | 0.852 |
| v) | -15 | 0.228 | 0.330 | 0.381 | 0.434 | 0.487 | 0.542 | 0.598 | 0.655 | 0.714 | 0.774 | 0.835 |
| vi) | -10 | 0.232 | 0.324 | 0.374 | 0.426 | 0.478 | 0.532 | 0.587 | 0.643 | 0.700 | 0.760 | 0.819 |
| vii) | -5 | 0.237 | 0.318 | 0.367 | 0.418 | 0.469 | 0.522 | 0.576 | 0.631 | 0.687 | 0.745 | 0.804 |
| viii) | 0 | 0.241 | 0.312 | 0.360 | 0.410 | 0.461 | 0.512 | 0.565 | 0.619 | 0.675 | 0.731 | 0.789 |
| ix) | 5 | 0.246 | 0.306 | 0.354 | 0.403 | 0.452 | 0.503 | 0.555 | 0.608 | 0.663 | 0.718 | 0.775 |
| x) | 10 | 0.250 | 0.301 | 0.348 | 0.396 | 0.444 | 0.494 | 0.545 | 0.598 | 0.651 | 0.706 | 0.762 |
| xi) | 15 | 0.254 | 0.296 | 0.342 | 0.389 | 0.437 | 0.486 | 0.536 | 0.587 | 0.640 | 0.693 | 0.748 |
| xii) | 20 | 0.259 | 0.291 | 0.336 | 0.382 | 0.429 | 0.477 | 0.527 | 0.577 | 0.629 | 0.682 | 0.736 |
| xiii) | 25 | 0.263 | 0.286 | 0.330 | 0.376 | 0.422 | 0.469 | 0.518 | 0.568 | 0.618 | 0.670 | 0.723 |
| xiv) | 30 | 0.268 | 0.281 | 0.325 | 0.369 | 0.415 | 0.462 | 0.509 | 0.558 | 0.608 | 0.659 | 0.711 |
| xv) | 35 | 0.272 | 0.277 | 0.320 | 0.363 | 0.408 | 0.454 | 0.501 | 0.549 | 0.598 | 0.648 | 0.700 |
| xvi) | 40 | 0.277 | 0.272 | 0.314 | 0.358 | 0.402 | 0.447 | 0.493 | 0.540 | 0.589 | 0.638 | 0.689 |
| xvii) | 45 | 0.281 | 0.268 | 0.310 | 0.352 | 0.395 | 0.440 | 0.485 | 0.532 | 0.579 | 0.628 | 0.678 |
| xviii) | 50 | 0.285 | 0.264 | 0.305 | 0.347 | 0.389 | 0.433 | 0.478 | 0.524 | 0.570 | 0.616 | 0.667 |
| xix) | 55 | 0.290 | 0:260 | 0.300 | 0.341 | 0.383 | 0.427 | 0.471 | 0.516 | 0.562 | 0.609 | 0.657 |
| xx) | 60 | 0.294 | 0.256 | 0.296 | 0.336 | 0.378 | 0.420 | 0.463 | 0.508 | 0.553 | 0.600 | 0.647 |
| xxi) | 65 | 0.299 | 0.252 | 0.291 | 0.331 | 0.372 | 0.414 | 0.457 | 0.500 | 0.545 | 0.591 | 0.638 |
| xxii) | 70 | 0.303 | 0.248 | 0.287 | 0.326 | 0.367 | 0.408 | 0.450 | 0.533 | 0.537 | 0.582 | 0.628 |
| xxiii) | 75 | 0.307 | 0.245 | 0.283 | 0.322 | 0.361 | 0.402 | 0.444 | 0.436 | 0.529 | 0.573 | 0.620 |
| xxiv) | 80 | 0.312 | 0.241 | 0.279 | 0.317 | 0.356 | 0.396 | 0.437 | 0.479 | 0.522 | 0.566 | 0.611 |
| xxv) | 85 | 0.317 | 0.238 | 0.275 | 0.313 | 0.351 | 0.391 | 0.432 | 0.472 | 0.515 | 0.558 | 0.602 |
| xxvi) | 90 | 0.321 | 0.235 | 0.271 | 0.308 | 0.346 | 0.385 | 0.425 | 0.456 | 0.508 | 0.550 | 0.594 |
| xxvii) | 95 | 0.225 | 0.232 | 0.267 | 0.304 | 0.342 | 0.380 | 0.419 | 0.450 | 0 501 | 0.543 | 0.586 |

**7.3.1** *Enclosure Volumes*

The net enclosure volumes are calculated using the following equations:

a) $V_{Max} = V_g - V_s$,

b) $V_{Min} = V_{Max} - V_o$

where

$V_{Max}$ = maximum net volume of the enclosure, $m^3$;

$V_g$ = gross volume of enclosure, $m^3$;

$V_s$ = volume of the structural/similar permanent objects in the enclosure that gas can not permeate, $m^3$;

$V_{Min}$ = minimum net volume of enclosure considering the maximum anticipated volume of the occupancy related to the objects in the enclosure, $m^3$; and

$V_o$ = volume of the occupancy related objects in the enclosure that gas can not permeate, for example, furniture fittings, etc, in $m^3$ ( This value shall be ignored if that volume is less than 25 percent of the maximum net volume $V_{Max}$ ).

## 8 DESIGN CONCENTRATION

a) Determination of design concentration of HCFC blend A shall include consideration of the type and quantity of combustibles involved, the conditions under which it normally exists in the enclosure, and any special conditions in the enclosure. The HCFC blend A system design shall be capable of establishing uniform design concentration throughout the protected volume.

b) The distribution system for applying HCFC blend A to enclosed hazards shall be designed with due consideration of the materials involved, the type of burning expected and the nature of the enclosure, anyone of which may affect the discharge times and rates of application.

c) The minimum design concentration of HCFC blend A for fires involving surface class A, and also fires involving flammable liquids and gases shall be as follows:

   1) The minimum design concentration of the HCFC blend A agent for Class A surface fire hazards shall be the extinguishing concentration ( 7.2 percent ) plus a loading of 20 percent as a safety factor.

   2) The minimum design concentration of the HCFC blend A agent for Class B fire hazards shall be the extinguishing concentration ( 7.2 percent ) with a loading of 30 percent as a safety factor.

   NOTE — Where different classes of hazards exist, design concentration shall be for the hazard requiring the greatest concentration.

d) *Requirements for flame extinguishment* — Tests shall be conducted in independent recognized laboratories for the determination of extinguishing concentration. This value as determined shall be loaded by a safety factor of 30 percent. In no case, shall the design concentration be less than 8.6 percent or such higher figure, determined by test as indicated above.

e) *Requirements for inerting*

   1) Minimum concentration requirements for inerting atmospheres within the enclosure involving flammable liquids and gases shall be as shown in Table 7. Where range of separate fuels is present, the inerting concentration shall be as shown in Table 7 for the fuel requiring the greatest concentration.

   2) For other fuels not listed in the Table 7, tests shall be conducted in independent recognized laboratories for the determination of inerting concentration. This value as determined from Table 7 shall be loaded by a safety factor of 10 percent. In no case, shall the inerting concentration be less than 8.6 percent or such higher figure, determined by test as indicated above.

f) Lastly, it is required to adjust the number of HCFC blend A agent containers, where necessary, by compensating for ambient pressure change due to location elevation as per **8**(g) and round off the number as before. The equation in such cases will be as follows:

$N_1 = N$ times atmospheric correction factor

where

$N_1$ = adjusted number of containers, and

$N$ = initial number of containers.

g) *Atmospheric correction factors* — It shall be necessary to adjust the actual HCFC blend A agent quantity for altitude effects. Depending upon the altitude, atmospheric correction factor shall be applied as per Table 8. The adjusted HCFC blend A agent quantity is determined by multiplying the number of HCFC blend A containers by the ratio of average ambient enclosure pressure to standard sea level pressure.

**Table 7 HCFC Blend A Design Concentration for Inerting**

[ *Clause* 8(e) ]

| Sl No. | Material | Percentage by Volume |
|---|---|---|
| (1) | (2) | (3) |
| i) | Acetone | 12.0 |
| ii) | Benzene | 12.5 |
| iii) | Methane | 18.6 |
| iv) | *n*-Heptane | 13.0 |
| v) | Propane | 18.3 |
| vi) | Mythyl ethyl ketone | 14.0 |
| vii) | Iso-butane | 18.4 |
| viii) | Difluoromethane ( HFC32 ) | 8.6 |

**Table 8 Atmospheric Correction Factors**

[ *Clauses* 7.3 *and* 8(g) ]

| Sl No. | Equivalent Altitude m | Enclosure Pressure mm Hg | Atmospheric Correction Factor |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| i) | -920 | 840 | 1.11 |
| ii) | -610 | 812 | 1.07 |
| iii) | -300 | 787 | 1.04 |
| iv) | 0 | 760 | 1.00 |
| v) | 300 | 733 | 0.96 |
| vi) | 610 | 705 | 0.93 |
| vii) | 920 | 678 | 0.89 |
| viii) | 1 220 | 650 | 0.86 |
| ix) | 1 520 | 622 | 0.82 |
| x) | 1 830 | 596 | 0.78 |
| xi) | 2 130 | 570 | 0.75 |
| xii) | 2 440 | 550 | 0.72 |
| xiii) | 2 740 | 528 | 0.69 |
| xiv) | 3 050 | 505 | 0.66 |

## 9 APPLICATION RATE, DURATION OF DISCHARGE AND DISCHARGE TIME

### 9.1 Design Application Rate

The design application rate shall be based on the quantity of HCFC blend A ($M_A$) as per **8**(c) and the duration of discharge required under **9.2**.

### 9.2 Duration of HCFC Blend A Discharge

The minimum theoretical injected concentration shall be achieved within 10 s and the actual injected concentration ( that is the above plus a suitable safety factor adjusted for container rounding off ) shall be achieved within 2 min.

### 9.3 Discharge Time for the HCFC Blend A Gas

The discharge time shall be the time for actuation of the first HCFC blend A container valve to the achievement of the required design concentration or the discharge time is the interval from the first appearance of liquid at the nozzle to the time when the discharge becomes predominantly gaseous, recognized by a change in the appearance and sound of the discharge.

a) The discharge time period is defined as the time required to discharge from the nozzles 90 percent of the agent mass at 21°C, necessary to achieve the minimum design concentration based on a 20 percent safety factor for flame extinguishment,

b) The discharge time required to achieve 95 percent of the minimum design concentration for flame extinguishment based on a 20 percent safety factor shall not exceed 10 s, and

c) Flow calculations performed in accordance with **12**, or in accordance with the approved pre-engineered systems, shall be used to demonstrate the discharge time requirements stated above.

## 10 STORAGE CONTAINERS

**10.1** The HCFC blend A storage containers shall comply with the following in addition to various requirements contained in IS 15493.

**10.1.1** The containers used in HCFC blend A systems shall be seamless cylinders designed, fabricated, inspected, certified and stamped in accordance with the requirements of Chief Controller of Explosives, Nagpur.

**10.1.2** The design pressure shall be suitable for the maximum pressure developed at 55°C or at the maximum controlled temperature limit.

**10.1.3** The containers shall be charged to a filling ratio ( fill density ) not greater than 900 kg/m$^3$ and not less than 500 kg/m$^3$.

**10.1.4** The containers shall be superpressurized with nitrogen (moisture content not greater than 0.005 percent by volume) to a total pressure of either 2.5 MPa ± 5 percent or at 4.2 MPa ± 5 percent measured at 21 ± 1°C.

**10.1.5** The storage containers shall have reliable means of indicating their pressure.

**10.1.6** The storage containers shall have reliable means of indicating the variation of container pressure with temperature. A pressure/temperature chart ( *see* Fig. 3 ) attached to the container, is acceptable.

**10.1.7** The requirements of authorities having jurisdiction for containers may take precedence over the requirements of this standard, if their specifications are more stringent.

## 11 DISTRIBUTION SYSTEM

The HCFC blend A distribution system shall comply with the following in addition to various requirements contained in IS 15493.

### 11.1 Piping Network

a) The piping shall withstand the maximum expected pressure at the maximum storage temperature, as follows:

   1) 2.5 MPa systems : 4.19 MPa at 55°C

   2) 4.2 MPa systems : 6.58 MPa at 55°C

b) The piping shall withstand the maximum developed pressure at 55°C and shall be in accordance with IS 15493.

c) Carbon steel pipes and fittings shall be galvanized inside and outside or otherwise suitably protected against corrosion. Stainless steel pipes and fittings may be used without corrosion protection.

NOTE — Stainless steel pipes may be used in all applications subject to appropriate design strength calculations.

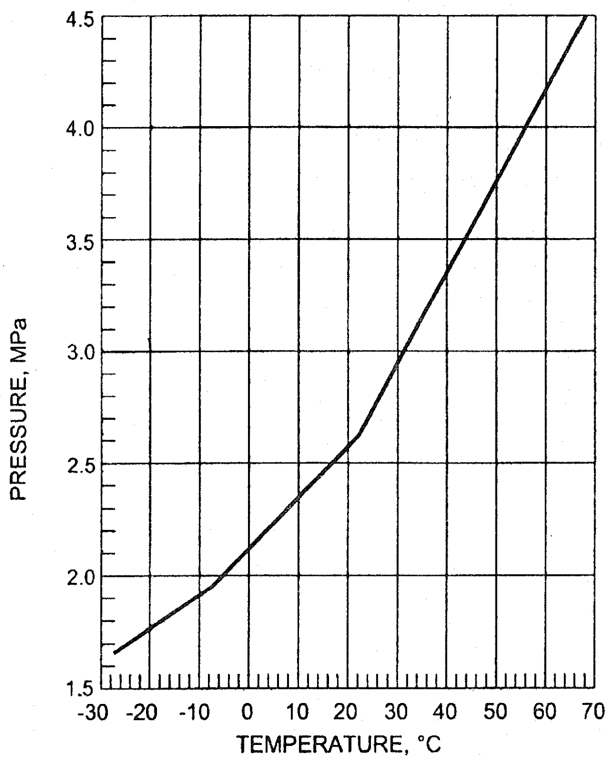
### 11.2 Piping Fittings

a) Pipe fittings shall comply with the requirements given in IS 15493.

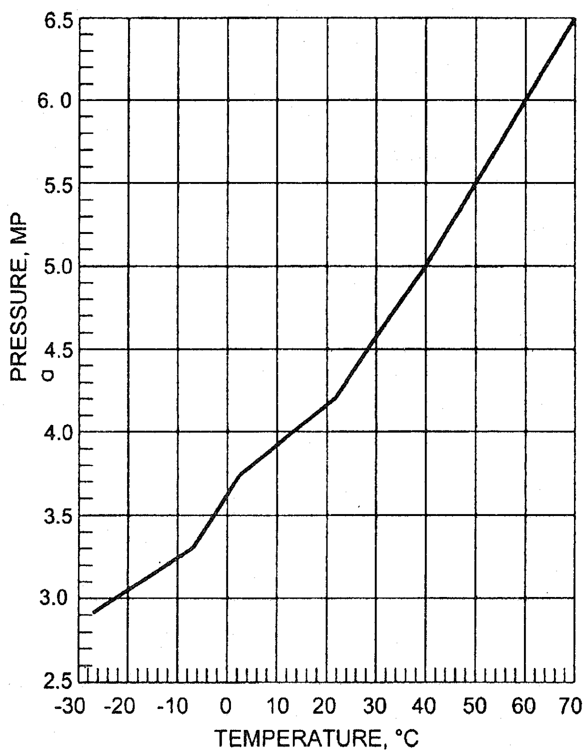
b) Fittings shall be selected according to the wall thickness or schedule number of the pipe to which they are intended to be fitted.

### 11.3 Pipe Sizing

Pipe sizing is a complex issue, particularly in view of the two-phase flow within the pipelines. Too small a bore results in excessive pressure losses while too large a bore reduces the liquid flow velocity. This also may result in excess pressure drops and lower flow rates. Table 9 may be used as a guide to estimate pipe sizes. The sizes can be checked using an approved computer flow calculation programme.




(a) 2.5 MPa nominal fill at 15°C




(b) 4.2 MPa NOMINAL FILL AT 15°C

FIG. 3 TEMPERATURE/PRESSURE VARIATIONS FOR HCFC BLEND A IN STORAGE CONTAINERS

**Table 9 Pipe Sizes *versus* Flow Rate ( Informative )**

( *Clause* 11.3 )

| Sl No. | Nominal Bore mm | Minimum Flow Rate, kg/s | Maximum Flow Rate for Equivalent Lengths of Pipe, kg/s | | |
|---|---|---|---|---|---|
| | | | More Than 10 m | Between 5 and 10 m | Up to 5 m |
| (1) | (2) | (3) | (4) | (5) | (6) |
| i) | 10 | 0.3 | 0.3 | 0.4 | 0.5 |
| ii) | 15 | 0.5 | 0.5 | 0.7 | 1.0 |
| iii) | 20 | 1.0 | 1.0 | 1.0 | 2.0 |
| iv) | 25 | 1.5 | 1.5 | 2.7 | 4.0 |
| v) | 32 | 2.6 | 3.5 | 5.6 | 8.0 |
| vi) | 40 | 3.8 | 4.5 | 8.6 | 12.2 |
| vii) | 50 | 5.9 | 8.8 | 16.3 | 23.5 |
| viii) | 65 | 8.8 | 14.5 | 25.4 | 37.0 |
| ix) | 80 | 15.0 | 25.0 | 45.0 | 63.5 |
| x) | 100 | 26.3 | 50.0 | 90.0 | 131.5 |
| xi) | 125 | 43.0 | 95.0 | 172.0 | 250.0 |
| xii) | 150 | 57.5 | 150.0 | 272.0 | 408.0 |

**11.4 Nozzle Placement**

a) The type of nozzles selected, their number and placement shall be such that the design concentration will be established in all parts of the protected enclosure and such that the discharge will not unduly splash flammable liquids or create dust clouds that could extend the fire, create an explosion, or otherwise adversely affect the contents or the integrity of the enclosure.

b) Selecting the number of nozzles in a system shall take into account, the shape of the enclosure ( area and volume ), shape of the void ( raised floor, suspended ceiling ), installed equipment in the enclosure/void ( chimney effect ), allowed pressure at the restrictor ( Pipe quality ) and obstructions, which may affect the distribution of the discharged agent and architectural considerations.

c) Nozzles shall be selected and located to protect an area less than its area of coverage. The area of coverage to the type of nozzle shall be so listed for the purpose.

d) In hazards having suspended ceiling, consideration shall be given for having nozzles installed in the ceiling void ( simultaneous discharge ) in order to equalize the pressure during discharge, thus reducing the risk of unnecessary damaging ceiling tiles etc.

e) In hazards having raised floor ( not gas-tight ) consideration shall be given for having nozzles installed in the floor void ( simultaneous discharge ) in order to equalize the pressure and obtain extinguishing concentration below the floor.

f) In hazards having suspended ceiling, nozzles for protecting rooms shall be installed in such a way that the jets from the nozzles do not damage the ceiling plates excessively during discharge, that is, the nozzles to be positioned vertically with the discharge holes free of the ceiling tiles and/or Escutcheon plates. For light weight ceiling tiles, it may be recommended to securely anchor tiles for a minimum of 1.5 m from each discharge nozzle.

g) Maximum nozzle height above floor level for a single row of nozzles is 3.5 m . Where ceiling height ( of the protected enclosure ) exceeds 3.5 m, an additional row of nozzles shall be provided for uniform and faster distribution of the agent within the enclosure.

h) Minimum nozzle height above the floor level of the hazard shall be 0.2 m.

j) The maximum distance between nozzles should not exceed 6 m and the maximum distance to wall/partition should not exceed 3 m.

k) In case of enclosures having no false ceiling, nozzles can be located on the ceiling anywhere within 0.5 to 5 m from the walls. In case of enclosures having false ceilings, deflector shields shall be used with each nozzle and also nozzles shall be so located ( with an anticipation of dislodgement of false ceiling materials or any movable objects in the path of discharge ) to prevent any damage thereto.

Nozzles shall be provided in all the concealed spaces, floor voids, ceiling voids, etc, besides the main area within the protected enclosure.

## 12 HYDRAULICS OF THE SYSTEM

### 12.1 General

a) An approved hydraulic calculation method shall be employed to predict pipe sizes, nozzle pressure, agent flow rate, discharge per nozzle and the discharge time.

b) The various parameters as stated below shall be considered to determine the following minimum limits of accuracy:

   1) The weight of agent predicted by flow calculation to discharge from the nozzle should agree with the total weight of agent actually discharged from each nozzle in the system within a range of –5 to +10 percent of actual prediction.

   2) The discharge time predicted by the flow calculation method should agree with the actual discharge time from each nozzle in the system.

   3) The accuracy of the calculated nozzle pressures *versus* actual pressures at each nozzle should be such that actual nozzle pressures in an installation will not fall outside the range required for acceptable nozzle performance.

   4) The nozzle pressure should not fall below the minimum or above the maximum nozzle pressure required for the nozzle to uniformly distribute the agent throughout the volume and to protect nozzle's discharge.

### 12.2 Two-Phase Flow of HCFC Blend A

The two-phase flow of HCFC blend A shall be in accordance to Annex B of IS 15493.

### 12.3 Engineered and Pre-engineered Systems

a) *General* — HCFC blend A is suitable for use in both engineered (central storage) systems and pre-engineered (modular or packaged) systems, as described in **12.3**(b) and **12.3**(c).

b) *Engineered* — An engineered system uses large storage containers installed in a central location. The containers are manifold together and a single pipe feeds the nozzle located inside the hazard area. Predicting pipe pressure losses and designing nozzle orifice sizes requires complex flow calculations for both HCFC blend A and nitrogen phases, which takes into account the minimum and maximum volumes or the enclosure ( *see* Fig. 4 ).

c) *Pre-engineered* — A pre-engineered system involves a single container with a maximum of two nozzles and a small piping network. This system can be multiplied to cover larger volume areas. The larger area is viewed as a number of smaller areas each protected by a single modular unit ( *see* Fig. 5 ).

## 13 POST DISCHARGE SCENARIO

The HCFC blend A system, when tested for discharge test, in accordance with the following requirements shall be:

a) Within 1 min of commencement of discharge, the concentrations at not more than 1 m above the floor of the enclosure or at the top of the highest hazard shall not vary from the design concentration by more than 1 percent by volume.

b) At 10 min of the discharge or other period ( as required if necessary ), the concentrations at the levels given in **13**(a) shall be not less than 80 percent of the design concentration ( Retention time ).

## 14 COMMISSIONING AND ACCEPTANCE TESTING

### 14.1 Criteria for Acceptance

The completed HCFC blend A total flooding system shall be commissioned in accordance with provisions of IS 15493 and the system's performance proved.

### 14.2 Reporting

The following shall be reported:

a) Information identifying the system shall include:

   1) Installation, designer and contractor;

   2) Enclosure identifications;

   3) Enclosure temperature prior to discharge;

   4) Oxygen and carbon dioxide residual concentrations; and

   5) Position of sampling points.

b) Date and time of test.

c) Discharge time.

d) Concentration levels at each sampling point at 2 min and 10 min from the commencement of discharge.

e) System deficiencies.

f) Reference to this test method in accordance with IS 15493.

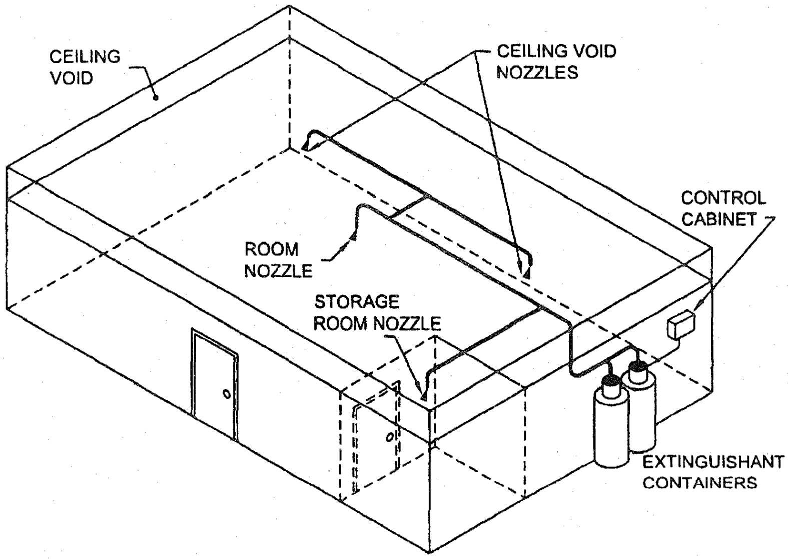



FIG. 4 TYPICAL ENGINEERED HCFC BLEND A SYSTEM

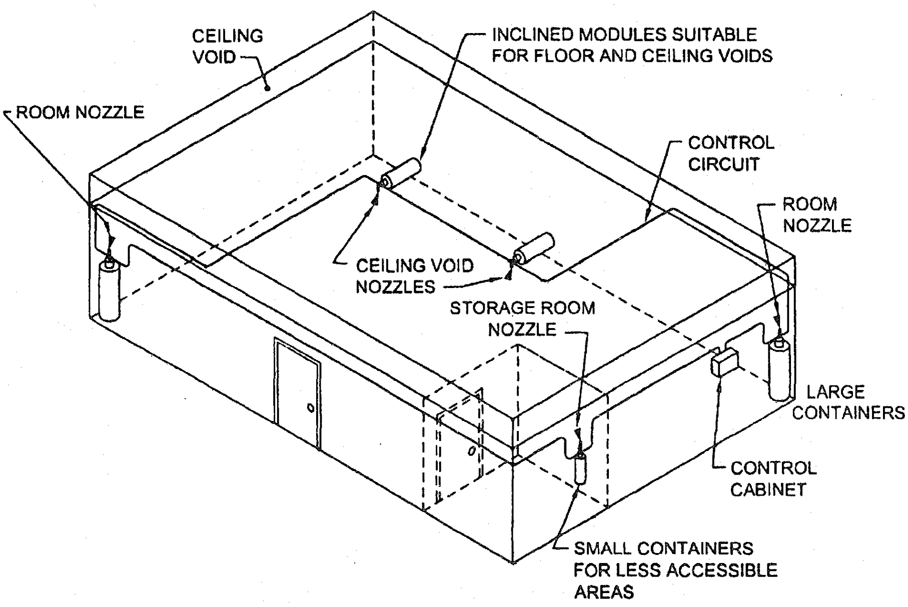



FIG. 5 TYPICAL PRE-ENGINEERED HCFC BLEND A SYSTEM

# ANNEX A

( *Clause* 4.5 )

## DETERMINATION OF PURITY OF HCFC BLEND A

**A-1** HCFC blend A is a blend of three single HCFC components and a detoxifier as given in Table 1. A random sampling of 10 percent of the production is undertaken to determine the quality of the production.

**A-2** Following the filling of production cylinder, a 1 kg sample is removed from the selected cylinder and stored in a sampling cylinder. A small amount of HCFC blend A is expelled from the valve until the liquid phase of the product is produced. A 1 litre capacity polypropylene sampling bag is connected to the cylinder and 2 ml of the blend is drawn into the bag. It is essential that only liquid blend is allowed to be sampled.

**A-3** The bag together with the sample of blend is conditioned by placing in an oven at 40°C for 20 min in order to ensure that a homogeneous gasified sample is produced. A sample of 1 microlitre is injected into the column of the gas chromatograph equipment and analysed. The percentage of each HCFC component shall be determined from the resulting chromatograph by comparison with the standard graphs [ *see* Fig. 6(a) and 6(b) ]. The areas of the chromatograph are measured automatically, converted to a percentage.

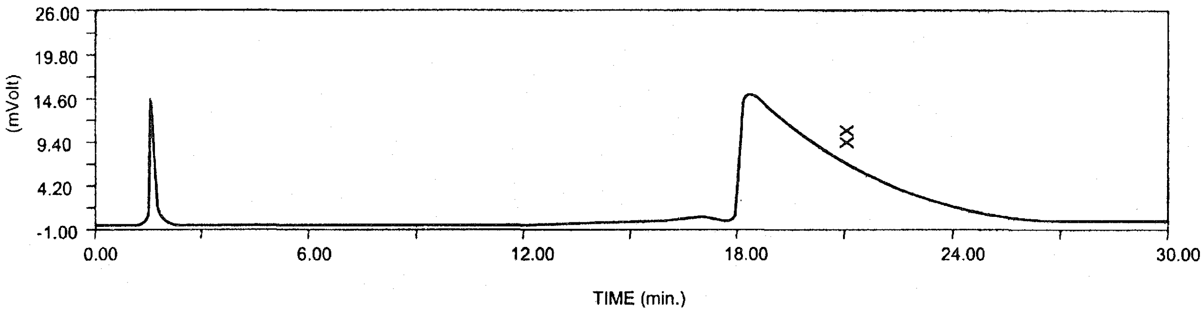
**A-4** The use of G.C. technique does not provide a sufficiently accurate analysis result in respect of the detoxifier component and therefore an additional procedure is used to determine this parameter, using a simple weighing technique.

**A-5** The cylinder containing the remaining sample of blend ( after determining the HCFC content ) is weighed accurately to an accuracy of 0.1 g. The gas phase ( HCFC ) of the sample is removed at an ambient temperature using a gas phase recovery technique. Care should be exercised to retain liquid phase.

The cylinder is then placed in a water bath at a temperature of 30°C and weighed periodically (15 min intervals ) until a stable weight recorded.

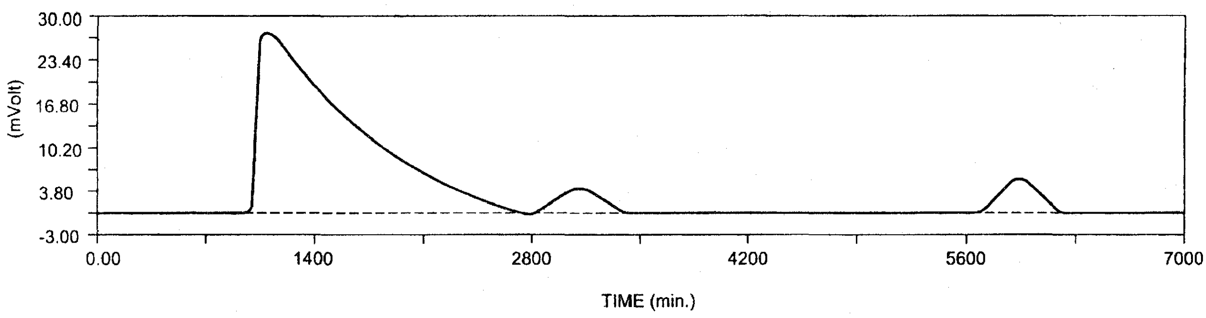
The remaining liquid is used for determination of the percentage weight of the detoxifying component, a simple weighing technique being used.

An additional gas chromatography should be performed on the resulting liquid at this stage to confirm that no HCFC remain in the sample.




| Component Name | Retention Time (*Min*) | Area (%) |
|---|---|---|
| *F* 123 | 2.100 | 5.480 |
| × × | 15.425 | 94.520 |

FIG. 6A CHROM-CARD STRIP-CHART OF HCFC BLEND A




| Component Name | Retention Time (*Min*) | Area (%) |
|---|---|---|
| *F* 22 | 1.333 | 85.249 |
| *F* 124 | 3.333 | 9.758 |
| *F* 123 | 6.083 | 4.994 |

FIG. 6B CHROM-CARD STRIP-CHART OF HCFC BLEND A